

BROADBAND SPECTRUM SURVEY AT DENVER, COLORADO

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NTIA is responsible for managing the Federal Government's use of the radio spectrum. In discharging this responsibility, NTIA uses the Radio Spectrum Measurement System to collect data for spectrum utilization assessments. This report details such a data collection effort spanning all of the spectrum from 108 MHz to 19.7 GHz in the metropolitan area of Denver, Colorado, during September and October of 1993.

Key words: land mobile radio (LMR); radar emission spectrum; radio spectrum measurement system (RSMS); radio frequency environment; spectrum resource assessment; spectrum survey

1. INTRODUCTION

1.1 Background

The National Telecommunications and Information Administration (NTIA) is responsible for managing the Federal Government's use of the radio spectrum. Part of this responsibility is to establish policies concerning spectrum assignment, allocation, and use; and to provide the various departments and agencies with guidance to ensure that their conduct of telecommunications activities is consistent with these policies.² In discharging this responsibility, NTIA 1) assesses spectrum utilization, 2) identifies existing and/or potential compatibility problems among the telecommunication systems that belong to various departments and agencies, 3) provides recommendations for resolving any compatibility conflicts that may exist in the use of the frequency spectrum, and 4) recommends changes to promote spectrum efficiency and improve spectrum management procedures.

Since 1973, NTIA has been collecting data on Federal use of the radio frequency spectrum in support of the NTIA Spectrum Analysis Program. The Radio Spectrum Measurement System (RSMS) is used by NTIA to provide technical support for 1) Spectrum Resource Assessments, 2) U.S. participation in the International Telecommunication Union (ITU) conferences and ITU Radiocommunication Sector (ITU-R) activities, 3) analysis of complex electromagnetic compatibility (EMC) problems, 4) interference resolution, and 5) systems review activity related to new Federal Government systems.

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²*NTIA, Manual of Regulations and Procedures for Federal Radio Frequency Management*, Part 8.3, U.S. Department of Commerce, National Telecommunications and Information Administration, Washington, D. C., revised May 1992, January 1993 and May 1993.

1.2 Authority

The RSMS is under the administrative control of the Director of the Institute for Telecommunication Sciences (ITS). The Deputy Associate Administrator of the Office of Spectrum Management (OSM) is responsible for meeting the spectrum management requirements of NTIA as transmitted to him by the Associate Administrator of OSM. RSMS measurement activities are authorized by the Deputy Associate Administrator of OSM in consultation with the Director of ITS. Federal agencies with spectrum management problems can request support of the RSMS through the Deputy Associate Administrator of OSM.

1.3 Purpose

Under Departmental Organizational Order 25-7, issued May 23, 1984, the Office of Spectrum Management is responsible for identifying and conducting measurements necessary to provide NTIA and the various departments and agencies with information to ensure effective and efficient use of the spectrum. As part of this NTIA measurement program, spectrum occupancy measurements are conducted using the RSMS. The spectrum occupancy data presented in this report do not include identification of specific emitters. The measured data are provided for the spectrum management community to:

- > enable a better understanding of how telecommunication systems use the allocated spectrum;
- > provide timely information on variations in frequency band usage, e.g., identify frequency bands becoming heavily used;
- > support the NTIA system review process by providing information on the availability of spectrum for new systems; and
- > assess the feasibility of promoting alternative types of services or systems that result in more effective and efficient use of the spectrum.

1.4 Extrapolation of Spectrum Usage Data

The extrapolation of data in this report to general spectrum occupancy for consideration of other shared uses of the spectrum can only be assessed after considering a number of factors. These include measurement area, measurement site, measurement system, spectrum management procedures, types of missions performed in the bands, and new spectrum requirements in the development and procurement stages.

The area chosen for a spectrum survey will affect measured spectrum usage. For example, the Denver area should be representative of many major metropolitan areas that do not have any maritime radionavigation or heavy military activity. Other cities, such as San Diego, may show high levels of activity in these bands.

The measurement site location within an area can also affect measured spectrum usage. An area such as Seattle-Tacoma (rough terrain and widely dispersed transmitters) may require multiple measurement sites to adequately characterize usage.

Spectrum management procedures such as band allotments for functions and missions affect spectrum usage. For example, channels used for taxi dispatch might show heavy use whereas channels allocated for law enforcement or public safety may show less use. Regardless of usage, dedicated channels for these safety-of-life functions remain a spectrum requirement. Special events such as natural disasters, Olympic games, and Presidential inaugurations also create unique spectrum requirements.

In summary, spectrum usage measurements alone cannot be used to assess the feasibility of using alternate types of services or systems in a band. However, spectrum measurements provide data on expected signal levels and probability of occurrences that are essential for assessing alternate uses of the spectrum. Such information cannot be obtained from databases or an understanding of spectrum management procedures.

2. OVERVIEW OF BROADBAND SPECTRUM SURVEYS

2.1 Introduction

Procedures for conducting a broadband spectrum survey using the RSMS are outlined in this section. Site selection factors and significant measurement system parameters are discussed. The measurement system hardware and software configurations developed for the surveys are also described. Detailed information on the system hardware (vehicle, instrumentation, antennas, receiver front-end), calibration procedures, and other measurement capabilities are provided in Appendix A. The measurement system control software (called "DA" for data acquisition) is described in Appendix B.

2.2 Survey Site Selection

A successful spectrum survey (also called a site survey) requires careful selection of a measurement site. Maximum signal intercept probability and minimum logistic problems are the first considerations when locating a site for an RSMS spectrum survey.

The primary signal intercept factors are 1) maximum line-of-sight coverage to increase the probability of weak signal reception such as transmissions from mobile units; 2) limited number of near-by transmitters to prevent intermodulation or saturation problems that can arise even though preselection and/or filtering is used for survey measurements; and 3) limited man-made noise such as impulsive noise from automobile ignition systems and electrical machinery that can add to the received signals of interest and give misleading results.

The primary logistic factors are 1) commercial power to increase the probability of completing the spectrum survey (typically two weeks of 24-hr operation) without power interruptions; 2) commercial telephone for relatively inexpensive reliable communications, compared to the RSMS cellular telephone that could possibly contaminate the measurements when transmitting; and 3) security of personnel, vehicle, and electronic hardware.